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VEGETABLE RESEARCH RESULTS 2006

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INTRODUCTION

This report summarizes the results of several vegetable studies conducted during 2006. We hope this type of information is of benefit to the vegetable industry in Ohio and the Great Lakes region. These reports are also available on the OSU Vegnet wesite at: http://vegnet.osu.edu. Your comments and suggestions for future efforts are always welcome.

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Use of ABA (Abscisic Acid) and PEG 8000 (Polyethylene Glycol) to Control Vegetable Transplant Height -2006

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Introduction: Vegetable transplants can become tall and leggy prior to field establishment, producing challenges for growers using mechanical transplanters to establish their crops. Preliminary greenhouse research in 2005 showed that the use of ABA reduced tomato transplant heights by as much as 67% compared to untreated control plants.

Materials and Methods: Plug trays were seeded on April 18 with 'BHN 685' plum tomatoes (288-cell plug trays) and 'Wahoo' bell peppers (200-cell plug trays). ABA (abscisic acid) was applied as a foliar application on June 1 at a rate of 100, 200 or 400 ppm five days before transplanting and PEG 8000 (polyethylene glycol) was incorporated into the growing mix (Metro-Mix) at the rate of 20g/liter of mix prior to seeding plug trays to control transplant height in vegetable transplants. Plots were mechanically transplanted on June 6 into raised beds spaced 5 feet apart with in-row plant spacing of 12 inches. Treatments were evaluated for their effect on transplant height control, field establishment, crop growth, and final marketable yield. Tomato plant height and stem diameter measurements were recorded prior to ABA application and 5 days after application (plant height only). Plant height, stem diameter, percent survival and dry weights were recorded 3 weeks after transplanting. The same measurements plus plant height 7 weeks after transplant were recorded on peppers. Tomatoes were harvested on September 26 and peppers were harvested on August 14, 29 and September 12.

Results: PEG incorporated into the growing mix prior to seeding significantly reduced plant height in both tomatoes and peppers prior to transplanting. ABA applied at the rates of 100, 200 and 400 ppm significantly reduced tomato transplant height 5 days after application (DAA) compared to untreated control plants while 100 and 200 ppm rates reduced pepper transplant heights at 5 DAA (Tables 1, 2). No differences in height were seen in either the tomatoes or peppers 3 weeks after transplanting, but there were differences in stem diameter in tomatoes (Table 1). There were no differences in final marketable yield in either crop. The use of ABA and PEG helped control transplant height prior to transplanting without adverse effects on final yield in both tomatoes and peppers.

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- Special thanks to the *Ohio Vegetable and Small Fruit Research and Development Program* and the *OARDC Small Industry Grant Program* for their financial support of this research.

- Thanks to *Seedway* for their seed donations for this project.

Table 1. Use of ABA and PEG 8000 to Control Fresh Market Vegetable Transplant Height - 2006

TOMATOES 'BHN685'

Prior to ABA Application:

Treatment	Plant ht. (cm)	Stem diam (mm)
Untreated	12.9	3.0
PEG	9.1	2.7
LSD	1.59	NS
CV	20.0	7.1

Treatment	---5 days after ABA application--- (at transplant) Plant ht. (cm)	------3 wks after transplanting------- Percent survival	Plant ht. (cm)	Stem diam. (mm)	Dry wt of 5 plants (gm)
Control	16.1	98	23.6	6.5	14.1
ABA 100 ppm	12.6	98	21.1	6.6	14.9
ABA 200 ppm	13.2	98	21.2	5.6	8.6
ABA 400 ppm	12.6	96	18.2	5.6	9.4
PEG	11.2	99	22.8	6.6	14.7
LSD	1.32	NS	NS	0.78	NS
CV	13.8	3.1	15.8	11.5	44.5

Treatment	Red T/A	Green T/A	Cull T/A	Percent red fruit	Avg. fruit wt. (lbs)
Control	7.6	10.2	6.3	32	0.27
ABA 100 ppm	9.3	13.2	10.7	28	0.32
ABA 200 ppm	13.1	15.6	6.8	35	0.29
ABA 400 ppm	9.1	10.9	7.8	31	0.35
PEG	8.8	11.6	10.7	31	0.32
LSD	NS	NS	NS	NS	NS
CV	61.8	40.3	72.3	25.0	31.2

Table 2. Use of ABA and PEG 8000 to Control Fresh Market Vegetable Transplant Height - 2006

PEPPERS 'Wahoo'

Prior to ABA Application:

Treatment	Plant ht. (cm)	Stem diam (mm)
Untreated	11.7	3.0
PEG	8.7	2.6
LSD	2.24	NS
CV	24.5	10.0

Treatment	---5 days after ABA application--- (at transplant) Plant ht. (cm)	------3 wks after transplanting------- Percent survival	Plant ht. (cm)	Stem diam. (mm)	Dry wt of 5 plants (gm)	7 wks after transplanting Plant ht. (cm)
Control	13.8	94	15.0	5.1	5.1	27.5
ABA 100 ppm	12.0	97	13.2	5.2	5.0	29.1
ABA 200 ppm	11.4	99	14.5	4.2	4.0	26.2
ABA 400 ppm	12.5	93	13.6	4.6	3.8	26.2
PEG	9.7	98	11.4	5.4	4.9	25.8
LSD	1.47	NS	NS	NS	NS	NS
CV	12.2	4.6	18.1	17.9	38.8	7.6

Treatment	Red T/A	Cull T/A	Avg. fruit wt. (lbs)
Control	4.4	2.1	0.41
ABA 100 ppm	4.4	2.3	0.41
ABA 200 ppm	4.9	2.0	0.39
ABA 400 ppm	3.7	2.2	0.40
PEG	4.1	2.1	0.40
LSD	NS	NS	NS
CV	18.8	31.5	9.0

Use of ABA for Processing Tomato Transplant Height Control – 2006

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Objective: To investigate the use of ABA (abscisic acid) as a drench application of 200 and 400 ppm solutions (1,000 ml per plug tray) to control height in processing tomato transplants. Treatments will be evaluated for their effect on transplant height control, field establishment, crop growth and final marketable yield. In a greenhouse study conducted in 2005, preliminary studies found that ABA applied at 200 and 400 ppm controlled tomato ('Peto 696') transplant height by as much as 67% compared to untreated controls.

Materials and Methods: 'OX 52' and 'Gem 611' were seeded into 288-cell plug trays on May 5. Plants were grown under standard practices in the greenhouse. On June 1, the 4 week old seedlings were drench treated with 200 or 400 ppm ABA solutions (1,000 ml per plug tray). Untreated controls were also compared to ABA treatments. Plants were measured prior to ABA application and again 5 days later at field transplanting. Plants were established on raised beds 5 feet apart with in-row plant spacing of 12 inches. Percent survival, plant height, stem diameter and dry weight of 5 plants was collected 3 weeks after transplanting. Plots were harvested on September 19.

Results: Five days after the initial ABA application, height control in 'Gem 611' was reduced by 11% and 31% with 200 and 400 ppm, respectively. Height control in 'OX 52' was reduced by 37% and 38% with 200 and 400 ppm, respectively. No differences in plant height were recorded 3 weeks after transplant (WAT), and there were no differences in percent plant survival. There were differences in stem diameter and plant dry weight. 'Gem 611' seedling dry weight responded strongly to ABA rates, but stem diameters were not affected. Conversely, 'OX 52' seedling weights were unaffected by ABA treatment, while stem diameters 3 WAT were increased by 400 ppm ABA drenches (Table 1). Marketable T/A for 'Gem 611' was unaffected by ABA treatments (4.1 T/A on the untreated control and 4.4 T/A for the 200 and 400 ppm treatments). Marketable yield for 'OX 52' ranged from 6.1 T/A for ABA 400 ppm, 7.4 T/A for ABA 200 ppm and 9.4 T/A for the untreated control (Table 1). Low yields throughout the plots are due to placement in a low lying field and heavy, untimely rains throughout the growing season in Northwest Ohio. Results this year show that ABA reduced plant heights 5 days after application but there were no differences after 3 weeks in the field (Table 1). ABA can be an effective height control strategy particularly when planting is delayed in the spring due to inclement weather at the time of field establishment. Unique cultivar responses to ABA in our 2006 research suggest that more study is needed to fine-tune this transplant height control strategy.

Acknowledgement:

- Special thanks to the *Mid-America Food Processors Association* for their financial support of this project and to *Dr. David Francis* (Ohio State University) for supplying seed for this research.

Table 1. Use of ABA for Processing Tomato Transplant Height Control - 2006

Prior to ABA Application:

Treatment	Plant ht. (cm)	Stem diam (mm)
'Gem 611'	6.4	2.4
'OX 52'	10.2	2.9

		5 days after ABA application	------3 wks after transplanting-------			
		(at transplant)	Percent	Plant ht.	Stem diam.	Dry wt of 5 plants
Cultivar	Treatment	Plant ht. (cm)	survival	(cm)	(mm)	(gm)
'Gem 611'	Control	9.8	96	17.5	6.7	9.89
'Gem 611'	ABA 200 ppm	8.8	97	16.2	6.7	7.46
'Gem 611'	ABA 400 ppm	6.8	94	15.0	6.4	5.94
'OX 52'	Control	16.8	97	16.7	5.4	7.17
'OX 52'	ABA 200 ppm	10.7	99	15.6	6.0	6.16
'OX 52'	ABA 400 ppm	10.5	98	14.6	6.6	6.77
LSD		1.23	NS	NS	0.76	2.42
CV		30.5	4.0	10.8	11.3	26.8

Cultivar	Treatment	Red T/A	Green T/A	Culls T/A	Avg. fruit wt (lb)	Percent red fruit
'Gem 611'	Control	4.1	5.0	2.8	0.09	35
'Gem 611'	ABA 200 ppm	4.4	6.8	1.7	0.09	33
'Gem 611'	ABA 400 ppm	4.4	5.3	1.3	0.09	40
'OX 52'	Control	9.4	6.8	2.3	0.08	51
'OX 52'	ABA 200 ppm	7.4	5.2	1.7	0.08	51
'OX 52'	ABA 400 ppm	6.1	5.6	1.8	0.07	46
LSD		3.5	NS	NS	NS	13.0
CV		50.5	45.6	50.3	29.5	24.3

Evaluation of New Vegetable Cultivars Under Northwest Ohio Growing Conditions - 2006

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Objectives: To evaluate new vegetable crop cultivars, focusing on fruit characteristics and yield potential in Northwest Ohio. New cultivar releases of tomato, pepper, eggplant and pumpkin will be evaluated under Ohio's soil types and environmental conditions along with disease resistance.

Materials and Methods: Tomato ('BHN 685'), eggplant ('Beatrice') and peppers ('Wahoo', 'Carmen' and 'Zsa Zsa') were seeded on April 18 and transplanted to the field on June 6 into raised beds with rows spaced 5 feet apart. Plants were spaced 12" apart within the rows. Each crop was replicated 4 times. Pumpkins ('Bat Wings') were seeded into 50-cell plug trays on May 15 and transplanted to the field on June 5 on black plastic mulch with rows spaced 7 feet apart and plants spaced 3' apart within the rows, replicated 4 times.

Results: Above normal rainfall and temperatures for the growing season caused a large percentage of blossom end rot in tomatoes and 'Wahoo' peppers. 'Wahoo' also had a significant amount of sunscald throughout all replications. Some bacterial wilt was confirmed on pumpkins. 'Carmen' and 'Zsa Zsa' peppers had very little blossom end rot or sunscald.

'BHN 685' tomato: Plants were seeded into 288-cell plug trays on April 18 and transplanted to the field on June 6. Plants were hand harvested on September 12. A large percentage of fruit had blossom end rot with a small percentage of late blight. No other diseases were noted. Final marketable yield was 7.6 T/A with 6.3 T/A culled fruit. Average fruit size was 0.27 lbs.

'Beatrice' eggplant: round to oval shaped firm, bright purple fruit. Plants were seeded into 200-cell plug trays on April 18 and transplanted to the field on June 6 into raised beds 5 feet apart and 12 inches between plants. Fruit was harvested on August 14, 29, September 12, 20. No disease problems were noted. Purple skinned with bright white interior. Marketable yield was 6.3 T/A and 1.4 T/A culled fruit. Average fruit weight was 1 lb. Fruit does not have a bitter taste. Nice variety for the eggplant market.

'Carmen' pepper: This 2006 All America Selection winner produces an Italian "bulls horn" type pepper. Fruits mature from green to deep red with a very sweet taste. Tapered fruit is 6 inches in length. Plants were upright with good foliage coverage. Fruits were harvested on August 29 and September 12. All fruits were harvested mature red. Marketable yield was 6.1 T/A with 0.6 T/A culled fruit. No disease or sunscald was present. Excellent sweet flavor for fresh use or roasting. Nice variety for fresh market sales.

'Wahoo' pepper: Plants were seeded into 200-cell plug trays on April 18 and transplanted to the field into raised beds 5 feet apart on June 6. Plant spacing was 12 inches between plants. Fruit was harvested on August 14, 29, and September 12. First fruits were difficult to harvest as fruit sets deep in the center of the plant. These bell peppers are thick walled and mature to a deep red. Blossom end rot and sunscald was noted on fruit in all harvests. Marketable fruit yield was 4.4 T/A with 2.1 T/A culled fruit. Average fruit weight was 0.41 lbs.

'Zsa Zsa' pepper: This Hungarian stuffing pepper matures from yellow to orange to red. Plants were seeded into 200-cell plug trays on April 18 and transplanted to the field on June 6 into raised beds. Rows were spaced 5 feet apart with a 12 inch spacing between plants. Plants were harvested on August 8, 29, and September 20. Fruit color at harvest provided a mixture of yellow, orange and red fruits. Average fruit size was 0.20 lb. Some blossom end red was present on fruit. Fruit is approximately 5 inches in length and tapers to a blunt end. Marketable yield was 5.1 T/A with 0.4 T/A culled fruit mainly due to blossom end rot. Nice variety for the colored pepper market.

'Bat Wings' pumpkin: Plants were seeded into 50-cell plug trays on and transplanted to the field on black plastic mulch on June 5 in rows 7 feet apart and in-row plant spacing of 3 feet. Plants are semi-bush type. Average fruit weight was .67 lbs. Total marketable yield was 6.7 T/A with 1.5 T/A culled fruit. Fruit are orange with various designs of black on the underside of the fruit and around the stem. Unique Halloween novelty pumpkin. No disease problems were noted.

Table 1.

Cultivar	Seed Source	Days to Maturity	Marketable T/A	Cull T/A
'BHN 685'	SW	76	7.6 (red) 10.2 (green)	6.3
'Beatrice'	JS	62	6.3	1.4
'Carmen'	JS	60(grn)/80 red	6.1	0.6
'Wahoo'	SW	74	4.4	2.1
'Zsa Zsa'	SW	65	5.1	0.4
'Bat Wings'	SW	90	6.7	1.5

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- Special thanks to *Seedway* for their seed donations.

Copper-Treated Containers for Vegetable Transplant Production – 2006

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Introduction: Preliminary data from 2005 showed that transplants grown in copper treated plug trays showed a trend for increased yields in melon ('Nitro') and winter squash ('Waltham Butternut'). Copper-treated containers have been used to promote a more uniformly developed root ball mass in tree seedling production versus untreated containers, which can lead to circling of roots. Research on copper treated containers may aid greenhouse and field vegetable growers in producing a more uniformly developed transplant root system with optimal seedling establishment and crop growth.

Materials and Methods: 50 cell plug trays were painted with 'Spin-Out' copper paint 2 weeks before seeding muskmelon 'Nitro' and winter squash 'Waltham Butternut'. An untreated check was compared to the copper treatment for transplant survival, crop development and final yield. Plants were seeded on May 15 and transplanted to the field on black plastic mulch on June 5. Rows were spaced 7 feet apart with plant spacing of 3 feet. Percent plant survival was recorded 3 and 4 weeks after transplant. Vine length was also measured from the main stem to the end of the vine 4 weeks after transplant. Reduction in plant survival in muskmelon was due to bacterial wilt (Table 1). Melons were harvested on August 14 and 23. Squash was harvested on September 12.

Results: There were no differences in squash plant survival 3 and 4 weeks after transplant but there was a difference in vine length (Table 1). There were no differences due to treatment in survival or vine length recorded in muskmelon. Final marketable yield showed no differences in either crop (Table 1). Due to heavy rains during the growing season and substantial (25-35%) plant loss in muskmelon due to bacterial wilt, further investigation in the use of copper-treated plug trays for vegetable production is needed.

Table 1. Copper-Treated Containers for Vegetable Transplant Production - 2006

Winter Squash 'Waltham Butternut'

Treatment	--3 WAT*-- % survival	------4 WAT------- % survival	vine length (cm)	Marketable number/A	Marketable T/A	Cull T/A
Untreated	98	98	21.0	11201	15.7	1.4
Copper treated	100	100	15.8	11512	15.7	1.6
LSD (0.05)	NS	NS	4.20	NS	NS	NS
CV	3.3	3.6	17.9	11.8	11.9	51.4

Muskmelon 'Nitro'

Treatment	--3 WAT*-- % survival	------4 WAT*------- % survival	vine length (cm)	Marketable number/A	Marketable T/A	Cull T/A
Untreated	98	77	12.8	1815	4.7	1.2
Copper treated	100	67	14.0	1504	4.7	1.7
LSD	NS	NS	NS	NS	NS	NS
CV	3.6	17.7	7.6	47.2	39.3	47.2

* WAT = weeks after transplant

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Organic/Transitional Edamame (Vegetable Soybean) and Sweet Corn Seedling Establishment – 2006

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Introduction: This project focuses on the use of organic/biological seed treatments for optimum stand establishment of sweet corn and edamame. Traditional seed treatments, due to their composition, cannot be used in organic production systems. Use of untreated seed often reduces seed germination and field stands. Organic/biological treatments may be useful to organic and transitional farmers when direct seeding crops such as sweet corn and edamame. This project will assess establishment when sown under greenhouse environmental conditions (year 1 – 2006) and field seedling establishment (2007) to maximize agronomic and horticultural usefulness.

Materials and Methods: Sweet corn ('Xtra-tender 272A') and edamame ('Envy') seed was treated with various biological treatments: Champion, PlantShield® HC, and *Pseudomonas fluorescens* strain Delaw 1 in 3 formulations (A, C, D) which differed only in the age and moisture content of the inoculum. All three formulations of *P. fluorescens* are suitable for organic production. Laboratory cold tests were performed on treated seeds and an untreated control. Seeds were also planted in plug trays in 4 replications of 50 seeds. Trays were put into a germinator at 60°F for 4 days (8 hours light, 16 hours dark). Trays were then transferred to a greenhouse bench and grown for an additional 7 days. Stand counts were recorded and 10 plants from each replication were sampled for dry weight accumulation.

Results: Results from year 1 of this 2 year project show no significant differences for edamame cold tests, plug tray emergence or seedling dry weights (Table 1). Sweet corn showed no differences due to seed treatment in plug tray emergence or seedling dry weights, but Champion treated seed showed a significantly higher percent germination in cold tests (Table 1). Field studies conducted in 2007 will show whether laboratory and greenhouse studies correlate to field seedling establishment.

Acknowledgements:

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- Special thanks to *Brian McSpadden Gardener* (Plant Pathology, OSU) for supplying the *P. fluorescens* strains and formulations used in this study.

Table 1. Organic/transitional edamame (vegetable soybean) and sweet corn seedling establishment - 2006

Sweet Corn - 'Xtra-tender 272A'

Treatment	Cold test (% germ)	Plug tray emergence (% germ)	Seedling dry wt. (gm)
Untreated	66	82	0.4
PlantShield HC	68	76	0.4
Champion	77	91	0.4
P. fluorescens strain Delaw1-A	58	87	0.3
P. fluorescens strain Delaw1-C	67	90	0.3
P. fluorescens strain Delaw1-D	67	92	0.4
LSD (0.05)	9.0	NS	NS
CV	11.2	11.0	13.4

Edamame - 'Envy'

Treatment	Cold test (% germ)	Plug tray emergence (% germ)	Seedling dry wt (gm)
Untreated	96	93	1.4
PlantShield HC	95	90	1.4
Champion	92	94	1.4
P. fluorescens strain Delaw1-A	94	88	1.5
P. fluorescens strain Delaw1-C	94	91	1.5
P. fluorescens strain Delaw1-D	96	95	1.4
LSD (0.05)	NS	NS	NS
CV	4.0	3.8	9.5

Day-Length During Seed Development Affects Germinability and Storability of Lettuce Seeds

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Introduction

- Among the factors affecting seed quality are the environmental conditions under which seeds are produced on the mother plant.
- Lettuce is one of the most important vegetable crops in USA and the world. The establishment of this species requires high quality seed, which may be better able to germinate under stressful conditions (e.g. high temperature).
- The relationship between seed germinability and storability remains poorly understood. This knowledge is important for management of seed stocks, germplasm conservation, and natural seed banks of weeds and wild species.
- The main objectives of this study were to determine (1) how day-length of the mother plant environment affects lettuce seed quality and (2) the relationship between seed germinability and storability.

Materials and Methods

Lettuce seeds of 'Tango' were produced in growth chambers under one of two treatments: i) short day (SD), consisting of 8 h of fluorescent light (~310 $\mu mol \cdot m^{-2} \cdot s^{-1}$) plus 16 h of darkness daily, and ii) long day (LD), consisting of 8 h of fluorescent light plus 8 h of incandescent light (~21 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and 8 h of darkness daily. In both treatments the temperature was 23°C, constant. The experiment was replicated three times using plants from different sowing dates. Each replication was considered a block and consisted of 10 plants randomly assigned to each treatment. The harvest was performed manually extracting only fully matured flower heads from each plant.

Seed evaluation: For each replication, 3 groups of 100 seeds were used for dry weight determination. For the standard germination test, 100 seeds per replication (in groups of 50) were planted over 2 blotter layers saturated in dH2O and germinated at 20°C with constant light. After 4 and 7 days normal seedlings only were considered as germinated. Other germination tests were conducted using 2 groups of 50 seeds per replication, planted over 2 layers of blotters saturated with dH2O or ABA solution. Germination (radicle emergence) was evaluated daily for 7 days. The germination index (GI) was calculated as the algebraic sum of the ratio of germinated seeds and days after sowing at the count moment. Germination in dark was performed using black petri dishes on a thermogradient table at 14, 19, 24, or 29°C; germination was evaluated 4 days after sowing. For the accelerated aging (AA) test lettuce seeds were aged at 41°C and ~100%RH by 72 h, and then germinated following the standard germination protocol. Normal seedlings were evaluated 10 days after sowing.

Seed storage: Seeds were stored in plastic boxes at two conditions: i) 30°C, 55% RH, and ii) 30°C, 74% RH. Standard seed germination was evaluated after 2, 4 and 6 months of storage.

The data were analyzed by the ANOVA procedure. Before the analysis, germination percentages and GI values were transformed to the arcsin of the square root of the fraction value. Correlation coefficients between different parameters of germinability and storability were calculated.

Results and Discussion

Lettuce seeds 'Tango' produced under LD were significantly heavier than those produced in SD conditions (Table 1). Heavier seeds are commonly believed to perform better, however the seeds from this experiment presented similar results for the standard germination test, which was close to 100% normal seedlings in both treatments and, under the same optimal conditions (20°C-light), seeds from the SD treatment germinated faster, which is represented by a lower GI (Table 1). Seeds from SD also showed significantly better germination (% and GI) at 30°C. Thermoinhibition of lettuce seed germination at high temperature is a frequent problem affecting lettuce crop establishment. Previous published reports (1, 2, 6) indicated that seed produced at higher temperatures (30/20°C) presented an improved germination at high temperature, however the effect of day-length on lettuce seeds thermoinhibition has not been reported. Day-length during seed production also affected the ability of lettuce seed to germinate at increased external ABA levels. As can be seen in Figure 1, in both treatments germination percentage and GI were reduced by higher ABA concentrations, however seeds from LD were more sensitive to this phytohormone. ABA has been traditionally associated with seed dormancy, and these results suggest that lettuce seed produced under SD presented a higher germinability, or less dormancy, than seeds produced under LD.

Dark germination was significantly higher in seeds from SD at 14, 19, and 24°C, but at 29°C seeds from both treatments had germinations close to 0% (Table 1). The light requirement for germination of lettuce seeds has been extensively studied (3, 4, 5, 8), and variations depending on cultivar (5) and germination temperature (3,7) have been reported. However, differences due to day-length during seed development have not been reported.

Seeds from LD performed better after AA, producing a higher fraction of normal lettuce seedlings than seed from SD (Table 1). These results suggested that seeds from LD, despite their lower germinability at sub-optimal conditions, would be more vigorous and long lived than seeds from SD. The evaluation of germination after 2, 4 and 6 months of storage at 74%RH (Figure 2) corroborated this assumption. No changes in germination were observed after storage at 55%RH (data not shown).

A negative correlation between lettuce seed germinability and storability parameters was observed (Table 2). The most negative (-0.98) and significant ($p < 0.00$) correlation was between dark germination at 19°C and standard germination after 4 months of seed storage at 30°C and 74%RH. These results suggest that physiological dormancy and storability would be inversely related, however a causal relationship remains unclear.

In summary, the results of this study indicated that day-length during seed development affected lettuce seed weight, germinability, and storability. In these experiments, 'Tango' lettuce seed germinability and storability were inversely related.

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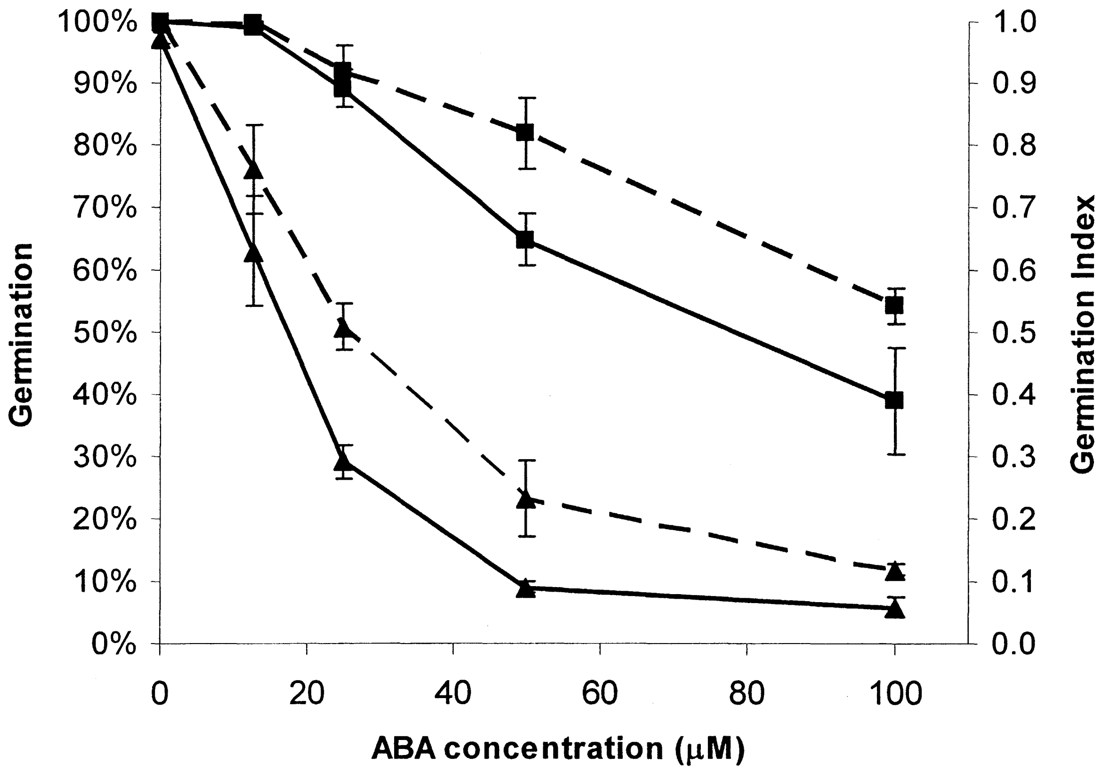

Figure 1. Lettuce seed germination percentage (square) and germination index (triangle) at different external abscisic acid concentrations of seeds produced under long (solid line) and short (broken line) days. Data are means ± SE of three replications.

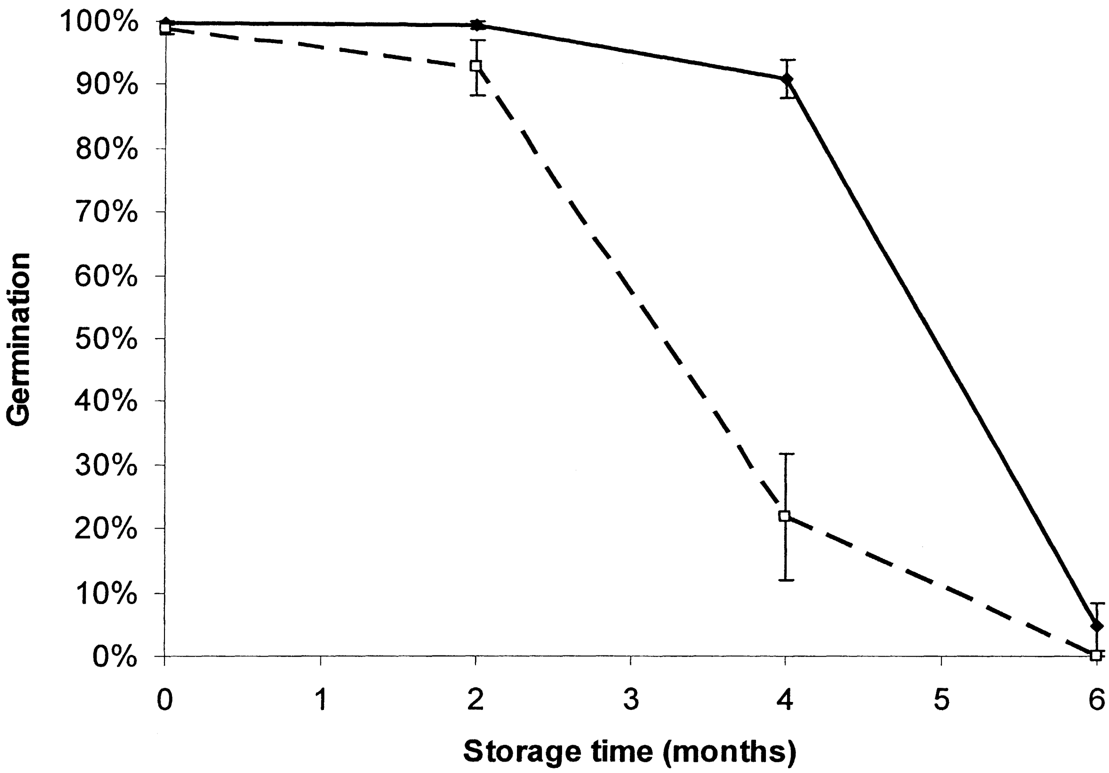

Figure 3. Lettuce seed germination percentage of normal seedlings after different storage periods at 30°C and 74%RH of seeds from long (solid line) and short (broken line) day treatments. Data are means ± SE of three replications.

Table 1. Parameters of quality for lettuce seed produced under long (LD, 16 h light) and short (SD, 8 h light) days.

Parameter	LD	SD	p-value[(1)]
Dry weight (mg/seed)	0.84	0.73	0.00
Germination % at 20°C	100	99	0.42
Germination Index at 20°C	0.98	1.00	0.02
Germination % at 30°C	21	60	0.03
Germination index at 30°C	0.05	0.35	0.06
Germination % after AA [(2)]	90	34	0.07
Dark germination % at 14°C	1	57	0.02
Dark germination % at 19°C	2	62	0.02
Dark germination % at 24°C	0	33	0.04

(1): calculated from analysis of variance.

(2): Accelerated aging for 72 h at 41°C and ~100%RH. Normal seedling percentages 10 days after planting are reported.

Table 2. Correlation coefficient between parameters of lettuce seed germinability and storability.

	Dark germination at 19°C	Germination in ABA, 50 mM	Germination at 30°C	Germination after AA
Germination after 4 months at 30°C and 74%RH	-0.983 (0.000)[(1)]	-0.586 (0.221)	-0.687 (0.132)	0.940 (0.005)
Germination Index after 4 months at 30°C and 74%RH	-0.865 (0.026)	-0.262 (0.616)	-0.401 (0.431)	0.821 (0.045)
Germination after accelerated aging (AA)	-0.984 (0.000)	-0.375 (0.463)	-0.469 (0.348)	___

(1): p-value for the correlation.

Development of germinability and desiccation tolerance in lettuce seeds.

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Introduction

For most seeds, maturation drying is the terminal phase of seed development (Kermode and Bewley, 1985). This maturation in seeds is generally terminated by some degree of drying, which results in a gradual reduction in metabolism as water is lost from the seed tissues and the embryo passes into metabolically inactive or quiescent state (Kermode, 1990). It has been suggested that desiccation, whether natural or imposed, plays an important role in the transition from developmental mode to germinative mode (Dasgupta and Bewley, 1982; Kermode and Bewley, 1985). This was observed in *Phaseolus vulgaris* and *Ricinus cuminis* in which imposed drying in immature seeds promoted germination (Kermode et al., 1986). In this study, seed development was monitored to achieve the following objectives:

1. Determine the onset of germination and desiccation tolerance.
2. Determine the germination of the seeds at different level of development under light and dark conditions.

Materials and methods

Fifteen plants of lettuce, cv. 'Tango', were used for seed sampling. These plants were grown in a greenhouse during Spring and Summer of 2005. Individual flower heads were tagged using colored strings during anthesis. Flower tagging was performed in three different days, and each opportunity was considered a replication. Sampling of seeds was done every other day starting at 3 days after flowering (DAF) until maturity at 17 DAF. Germinability was evaluated in fresh (immediately after harvest) and desiccated seeds. Desiccation was accomplished by placing the seeds over sodium bromide solution (53%RH) incubator in a incubator at 25°C.Germination of 50 seeds per replication was done in plastic Petri dishes with moist blotter paper under light and dark (covered with aluminum foil) conditions and incubated at 20°C. Germination (radicle protrusion) under light was scored daily for 15 days. Final dark germination was evaluated after 15 days. Moisture content of the seeds was measured gravimetrically after drying the seeds (50 per replication) in an oven set at 103°C for 48 hours.

Results and discussion

Figure 1 shows the evolution in weight (fresh and dry) and moisture content (MC) of lettuce seeds during their development. Seed fresh weight presented a rapid increase from

0.6 mg (3DAF) to ~1.3 mg (7DAF), and started decreasing 13 DAF. This decrease in seed fresh weight indicates that the seeds are undergoing maturation drying. Seed dry weight presented a gradual increase until it reaches a maximum of ~0.8 mg 13 DAF, which represented physiological maturity and was also coincident with a rapid decrease in seed MC from 40% to ~20% at 17 DAF. Figure 2 showed the dry weight and moisture content of the seeds at different stages of development after drying for 2 d in 53% RH at 25°C. The seed MC decreased until 7 DAF and reached a plateau 9 DAF to 17 DAF. Drying seeds at 3 DAF resulted to 66% reduction in their MC from 80% to 14% while only 13% (from 20% to 7%MC) in seeds sampled at 17 DAF. This may be due to the changes in chemical composition such as accumulation of lipids in the seeds as it matures.

Germination of some lettuce genotypes requires light, such as the case of cv. 'Tango' used in this study. Mature seeds of 'Tango' do not germinate under dark condition at 20°C. Figure 3 shows the germinations of both fresh and desiccated seeds under light and dark conditions at different stages of development. The capacity to germinate was observed at 5 DAF for fresh seeds. This indicates that seeds of this lettuce genotype germinated even before they reached physiological maturity at 13 DAF (Figure 1). Germination of fresh seeds at 5 DAF achieved 80 and 60% germination under light and dark conditions, respectively. Under light condition, germination of fresh seeds rapidly increased to 100% at 7 DAF and maintained at this level until 17 DAF. Under dark condition, germination of fresh seeds decreased from 60% at 5 DAF to 0% at 9 DAF and germination was again observed at 11 DAF and rapidly increased to a maximum germination of ~70% at physiological maturity. After this peak, germination again decreased. The onset of germination for the desiccated seeds was observed at 7 DAF for both light and dark conditions. Under light condition, desiccated seeds had 15% germination at 7 DAF and rapidly increased to 95% at 9 DAF and achieved 100% germination at 11 DAF. Under dark, germination of desiccated seeds was 10% at 7 DAF and increased to 20% at 9 DAF but decreased to 10% germination at 11 DAF. These values demonstrate than germination capacity varies during seed development. However, these findings show that desiccated seeds have a peak dark germination (~55%) coincident with fresh seeds at physiological maturity. After this point, germinability in dark decreased to less than 10% at 17 DAF, which is the commonly observed value for mature and desiccated seeds of this lettuce genotype. This dark germination is significantly lower that in mature fresh seed (~50%), which may be explained by degradation of the activated form of phytochrome during the desiccation process. The germination curve with two peaks observed for fresh seeds in dark suggests that, depending on the seed developmental stage, two different physiological mechanisms could be restricting dark germination. Currently, possible anatomical and/or hormonal mechanisms are been investigated.

In summary, these finding show that:

- This lettuce genotype can germinate at 5 DAF even before the physiological maturity (13 DAF) is achieved.
- Onset of desiccation tolerance was observed at 7 DAF.

- Imposed drying did not switch the physiological condition of the seeds from developmental to germinative mode.
- Germination of fresh seeds in the dark suggests that two physiological mechanisms restrict germination.

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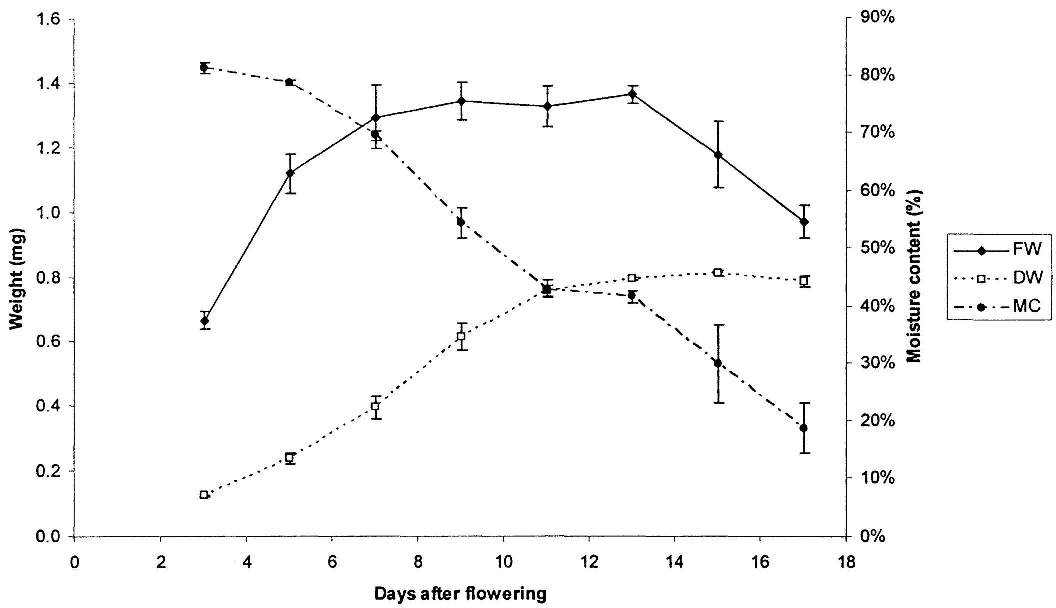

Figure 1. Fresh (FW), dry weight (DW) and moisture content (MC) of lettuce seeds at different stages of development. Dates are means ± SE of 3 replications of 50 seeds.

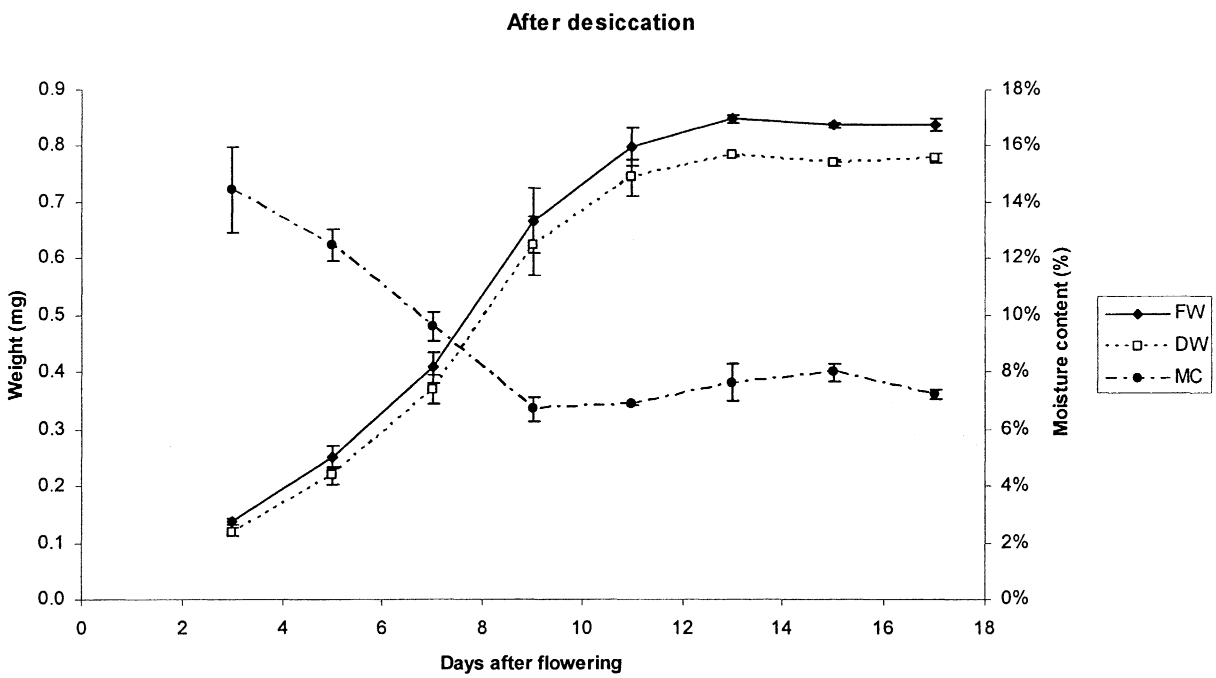

Figure 2. Fresh (FW), dry weight (DW) and moisture content (MC) of lettuce seeds at different stages of development after desiccation at 53% RH and 25°C. Dates are means ± SE of 3 replications of 50 seeds.

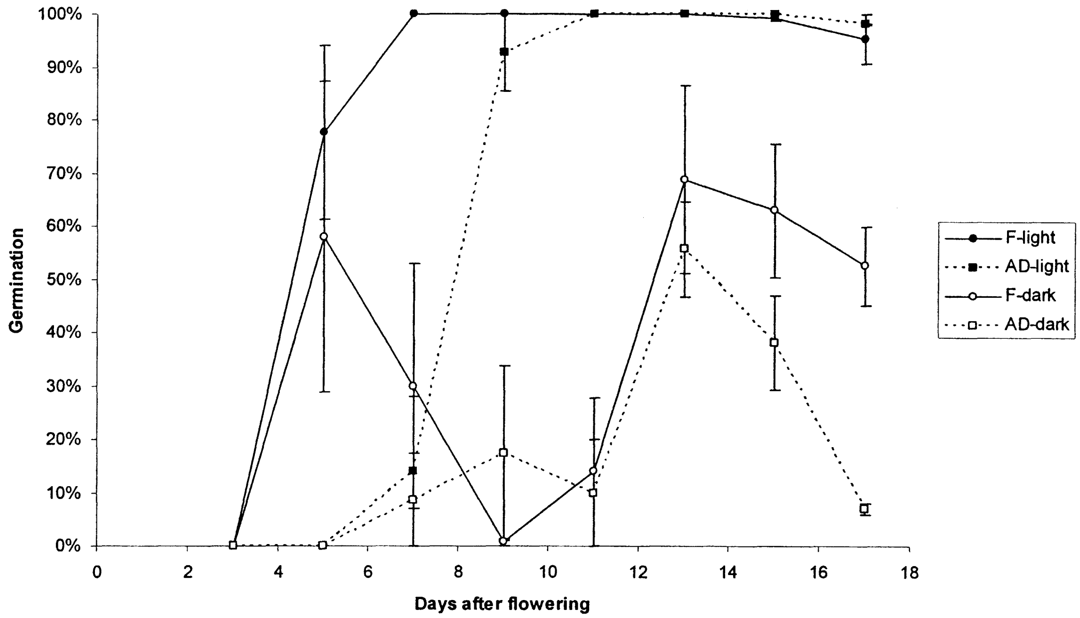

Figure 3. Total germination (%) of fresh (F) and desiccated (AD) seeds germinated under light and dark condition at 20°C. Dates are means ± SE of 3 replications of 50 seeds.

Cold Test Results for Sweet Corn Seed Treatments- 2006

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Objective: Twelve seed treatment combinations plus an untreated control were tested on two cultivars of sweet corn (*sh_2* 'Krispy King' and *se* 'Luscious') to determine the best seed treatments under laboratory cold test conditions.

Materials and Methods: Four replications of 50 seeds each were planted on moistened (500 ml of tap water) kimpak towels, covered with one quart of a soil/sand mixture, and placed at 10°C for one week, then at room temperature for 4 days. Germinated seedlings with both roots and shoots were counted.

Results: For 'Krispy King' (sh_2), only seed treatment 12 (Apron/A14115A/ Dividend Xtreme/Cruiser) had a higher germination value than any the untreated check. Seeds treated with Yield Shield/TC 1/Spinosad (treatment 7) and seed treatment 10 had the lowest germination (Table 1). For 'Luscious' (se), four seed treatments (3, 8, 9, and 12) were associated with improved seed germination vs. the untreated check.

This was part of a multi-location project organized by the Seed Treatment Committee of the International Sweet Corn Development Association, a non-profit research organization. The information generated from this study will be of value to sweet corn producers, industry personnel, consultants, farm advisers, extension plant pathologists and others interested in identifying the best performing seed treatments for optimum stand establishment.

Table 1. Cold test results for sweet corn seed treatments - Columbus, OH. 2006.

Trt #	Seed Treatment	Rate	'Krispy King' (sh2)	'Luscious' (se)
			------------Percent germination----------	
1	Untreated check		68	78
2	Captan 400	3.00 oz/cwt	72	87
	Thiram 42S	2.50 oz/cwt		
	Allegiance FL	0.75 oz/cwt		
3	Captan 400	3.00 oz/cwt	70	93
	Thiram 42S	2.50 oz/cwt		
	Allegiance FL	0.75 oz/cwt		
	L1243-A	5.53 oz/cwt		
4	Captan 400	3.00 oz/cwt	66	85
	L1243-A	4.80 oz/cwt		
	L1028	0.08 oz/cwt		
	Allegiance FL	0.75 oz/cwt		
5	Trilex FL	0.96 oz/cwt	61	87
	L1243-A	4.80 oz/cwt		
	L1028	0.08 oz/cwt		
	Allegiance FL	0.75 oz/cwt		
6	Captan 400	3.00 oz/cwt	63	84
	Thiram 42S	2.50 oz/cwt		
	Allegiance FL	0.75 oz/cwt		
	L1243-A	5.53 oz/cwt		
	Poncho 600 FS	0.25 mg AI/seed		
7	Yield Shield (Biological)	0.01 oz/cwt	56	81
	TC 1	0.01 oz/cwt		
	Spinosad 120 SC	1.00 oz/cwt		
8	Apron XL 3 LS	0.19 fl oz/cwt	66	90
	Maxim 4 FS	0.08 fl oz/cwt		
	Dividend Xtreme 0.96 FS	2.00 fl oz/cwt		
9	Maxim 4 FS	0.08 fl oz/cwt	67	92
	Apron XL 3 LS	0.31 fl oz/cwt		
	Dynasty 0.83 FS	0.15 fl oz/cwt		

Table 1.
(continued)

10	Apron XL 3 LS	0.19 fl oz/cwt	56	88
	Dynasty 0.83 FS	0.15 fl oz/cwt		
	Maxim 4 FS	0.08 fl oz/cwt		
	Dividend Xtreme	2.00 fl oz/cwt		
	Cruiser 5 FS	0.25 mg/seed		
11	A14115A	0.139 mg/seed	74	88
	Apron XL 3 LS	0.23 fl oz/cwt		
	Cruiser 5 FS	0.125 mg/seed		
12	Apron XL 3 LS	0.104 fl oz/cwt	78	90
	A14115A	0.139 mg/seed		
	Dividend Xtreme	2.00 fl oz/cwt		
	Cruiser 5 FS	0.125 mg/seed		
13	Natural II (Biological/Organic)	3.2 oz/cwt	66	87
	LSD (0.05)		8.6	10.7
	CV		12.3	6.9

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